



# NASA Johnson Space Center

## Leading Human Space Exploration

NASA Advisory Council  
Commercial Space Committee

Ellen Ochoa, JSC Deputy Director  
May 1, 2012



# Overview

## Key Questions

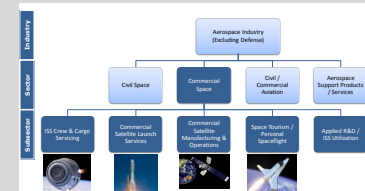
- How is the Agency's commercial space strategy message being perceived at the Center?
- What is the Center doing to promote it?
- What are the Center's plans for transitioning from the Shuttle and Constellation programs to the new Agency direction that includes commercial space, and how are those plans progressing?
- How is the Center addressing excess capacity issues?
- Do you have any concerns or issues with transitioning to the Agency's commercial space strategy?

## JSC Response

### JSC Strategic Implementation Plan



### Commercial Space Partnership Support



### Overarching Partnership Strategy



### Discussion on Challenges Ahead





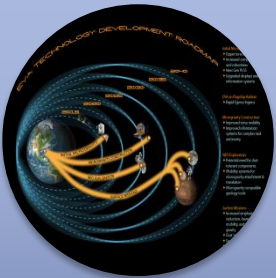
# JSC Strategic Implementation Plan

# Agency Strategic Plan

**VISION** To reach for new heights and reveal the unknown,  
so that what we do and learn will benefit all humankind

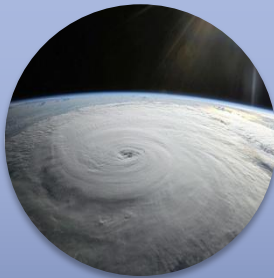
**MISSION** Drive advances in science, technology, and exploration  
to enhance knowledge, education, innovation, economic vitality,  
and stewardship of Earth

## STRATEGIC GOALS



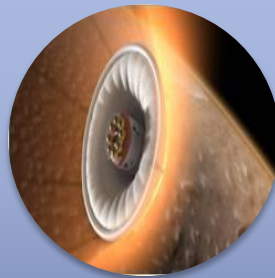
### Goal 1

Extend and sustain human activities across the solar system



### Goal 2

Expand scientific understanding of the Earth and the universe in which we live



### Goal 3

Create innovative new space technologies for our exploration, science, and economic future



### Goal 4

Advance aeronautics research for societal benefit



### Goal 5

Enable program and institutional capabilities to conduct NASA's aeronautics and space activities

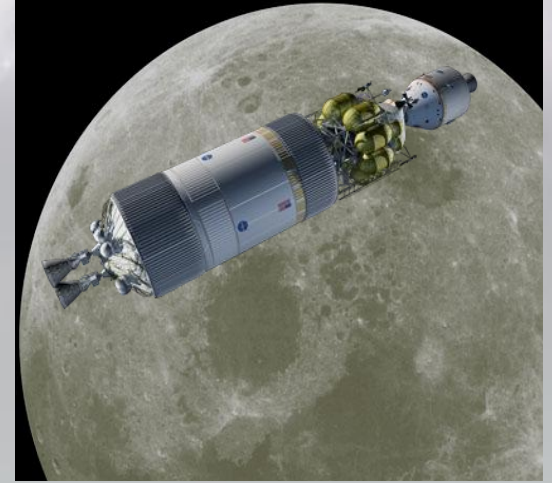
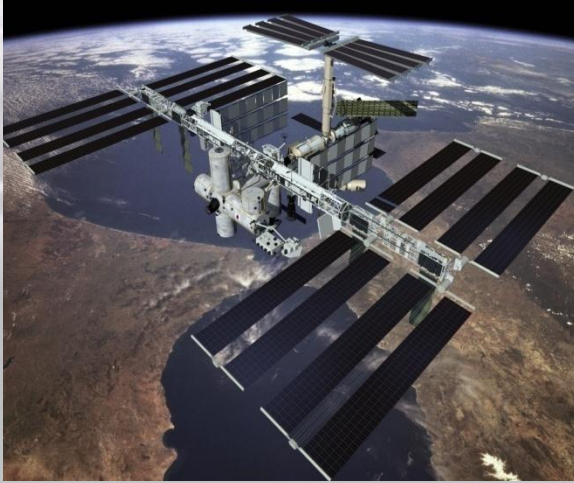


### Goal 6

Share NASA with the public,... to participate in our Mission, foster innovation, and contribute to a strong national economy



# JSC Vision & Mission



**Vision** – *Declaration of our future:*

**JSC leads a global enterprise in human space exploration that is sustainable, affordable, and benefits all humankind.**

**Mission** – *Our value proposition:*

**JSC provides and applies the preeminent capabilities to develop, operate, and integrate human exploration missions spanning commercial, academic, international, and US government partners.**

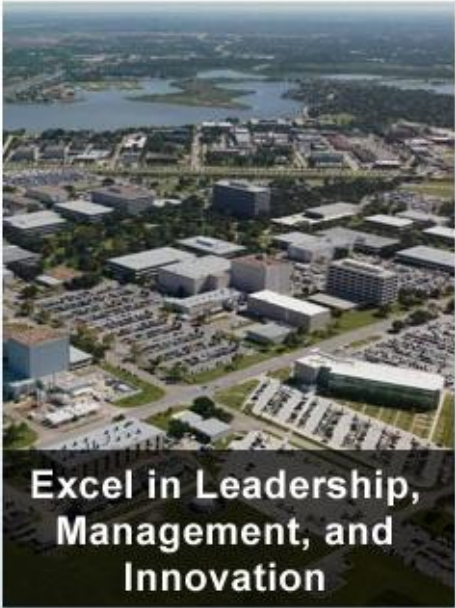




**Lead Human Exploration**



**Lead Internationally**



**Excel in Leadership,  
Management, and  
Innovation**



**Expand Relevance to  
life on Earth**

**JSC STRATEGIES SUPPORT EXPLORATION AND COMMERCIALIZATION**

- Strategy 1.1  
Exploit the ISS as a  
cornerstone of human  
exploration
- Strategy 1.2  
Enable the  
commercialization of LEO
- Strategy 1.3  
Extend human exploration  
beyond LEO

- Strategy 2.1  
Leverage ISS experience to  
lead international  
community participation in  
human space exploration
- Strategy 2.2  
Guide development of  
Agency Global Exploration  
Roadmap
- Strategy 2.3  
Champion international  
participation in the  
development of exploration  
capabilities

- Strategy 3.1  
Lead through innovative  
technical and business  
management practices
- Strategy 3.2  
Lead by Fully engaging the  
human spaceflight team

- Strategy 4.1  
Intertwine JSC in mutually  
beneficial partnerships to  
maximize economic and  
societal impact
- Strategy 4.2  
Inform, educate and engage  
all generations to advance  
human space exploration
- Strategy 4.3  
Strategically communicate  
JSC’s relevance in terms  
meaningful to our  
stakeholders



# Commercial Space Partnerships

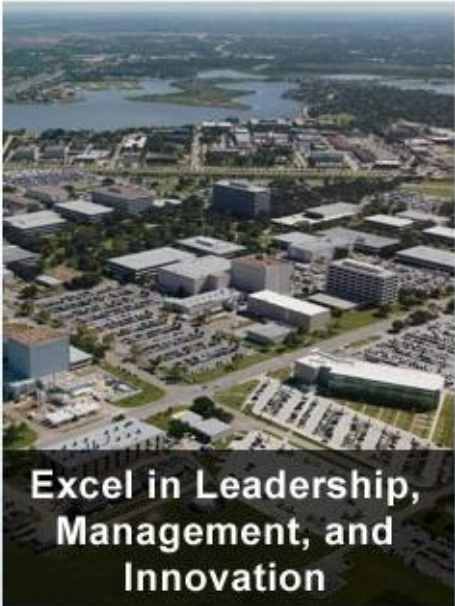




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## JSC STRATEGIES SUPPORT EXPLORATION AND COMMERCIALIZATION

Strategy 1.1  
Exploit the ISS as a  
cornerstone of human  
exploration

**Strategy 1.2**  
**Enable the**  
**commercialization of LEO**

Strategy 1.3  
Extend human exploration  
beyond LEO

### Success Factors:

- Enable the success of commercial partners by providing technical expertise, ISS domain knowledge, facility usage, and serving as a key customer for services
- Support the development of additional commercial opportunities in space such as satellite servicing, orbital debris removal, expanded access, and R&D platforms



# Enabling Success of Commercial Space

- **Through the program offices, JSC performs oversight/insight functions for companies providing commercial crew and cargo services to the ISS**



Commercial Orbital Transportation Services (COTS) /  
Commercial Crew & Cargo Program Office (C3PO)



ISS Program Office

- JSC manages the Commercial Resupply Services (CRS) contract



Commercial Crew Program (CCP)

- JSC is actively participating on Partner Integration Teams

- **Partnerships through Reimbursable and Non-Reimbursable Space Act Agreements provide direct support to companies and permit access to unique JSC facilities and capabilities**
- **JSC manages the Innovative Lunar Demonstrations Data (ILDD) contract to purchase data associated with industry efforts to design and demonstrate end-to-end robotic lunar landing missions**
  - Opportunity for NASA to complement Google Lunar X-Prize



# NASA Funded Activities Managed at JSC

## COTS Funded SAA's

### Partners

Orbital Sciences

SpaceX



## CCDEV Funded SAA's \*

### Partners

SpaceX

Sierra Nevada Corp.

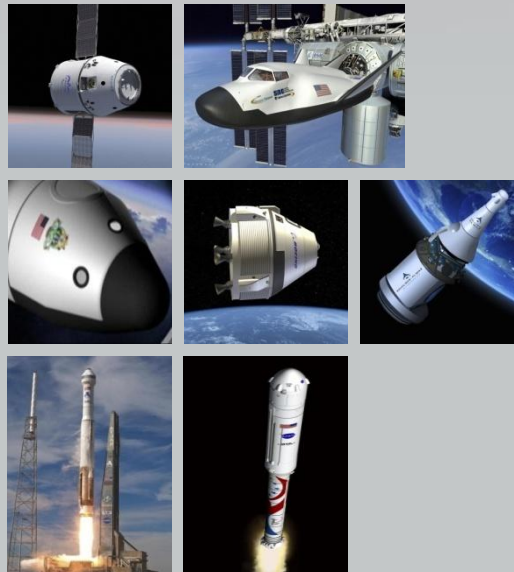
Blue Origin

Boeing

Excalibur Almaz

ULA

ATK



## ILDD Contract

### Partners

Astrobotic Technology

Charles Stark Draper Lab

Dynetics

Earthrise Space

Moon Express

Team FREDNET - The Open Space Society

## CRS Contract

### Partners

Orbital Sciences

SpaceX

\* Managed by the Commercial Crew Program at KSC with support offices at JSC



# JSC Commercial Space Partnerships

## Active Reimbursable Space Act Agreements

Partners	Technical Areas
Blue Origin	Component Refurbishment and Cleaning
Sierra Nevada Corp.	Technical Services for Spacecraft Design GN&C Analysis Activities Interface and Operations Development
SpaceX	Fastener Testing & Support Hypergolic Materials Testing and Support COPV Damage Detection Training Course
Boeing	Heat Shield Ablator Testing Thruster Testing Interface and Operations Development Engineering and Test Services Support Technical Services for Spacecraft Design
ULA	Pyrovalve Testing
Scaled Composites	Consulting, Testing, and Analysis
Bigelow	Expandable Space Structures & Materials
ATK	Technical Services for Spacecraft Operations

## Active Non-Reimbursable Agreements

### Partners

Ad Astra Rocket Company

## Non-Reimbursable Agreements in Progress

### Partners

Orbital Sciences

ULA





# Working with Other Agencies

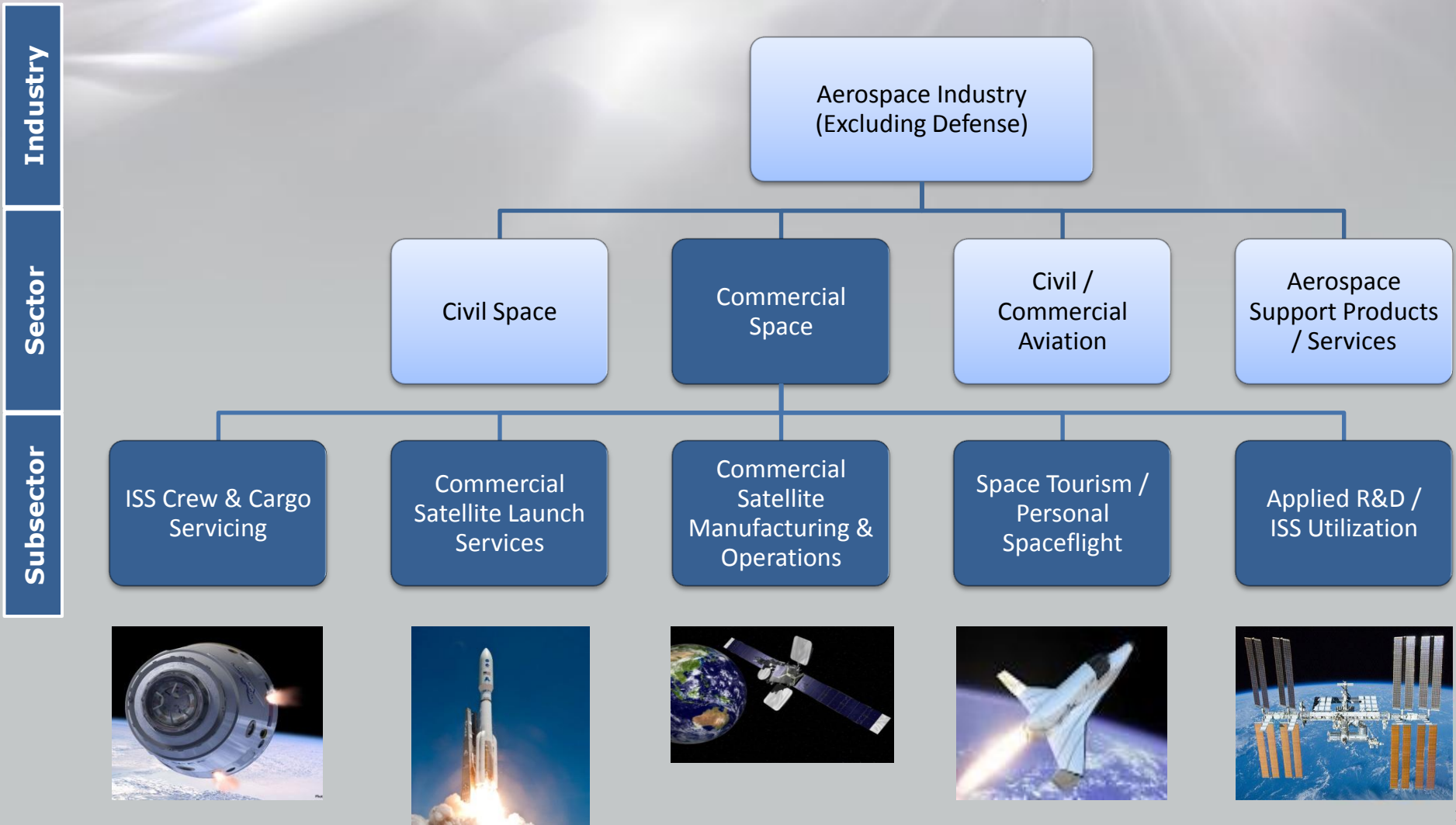
*Effective coordination between NASA and other government agencies, such as the FAA, is critical to the success of the commercial space sector*

- **Through the Commercial Crew Program, JSC works with the FAA Office of Commercial Space Transportation on crew and public safety regulations in an effort to avoid duplicative and overly burdensome requirements on commercial crew companies**
  - Actively helping to find the right balance for crew and public safety
- **Partnering with the FAA Center of Excellence for Commercial Spaceflight**
  - Spaceflight participant and crew medical guidance
  - Medical database for spaceflight participants
  - Risk mitigation related to aerospace physiology
- **JSC has also been exploring collaboration opportunities with the FAA and Air Force Research Lab (AFRL) on human systems integration and human factors related topics of interest to all three agencies**



# Serving All Commercial Space Markets

*JSC has expertise relevant to all markets of Commercial Space*



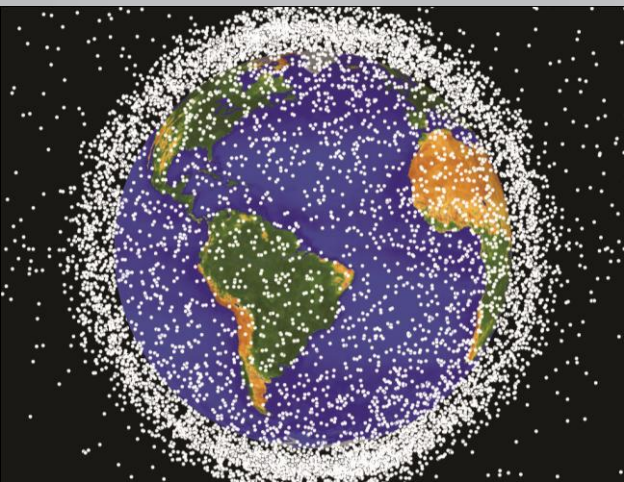
# Meeting Commercial Space Needs

*JSC's core capabilities can meet the needs of all markets that comprise the Commercial Space sector*

	JSC Core Capabilities									
	Mission Planning, Training, & Execution	Engineering Systems Testing	Systems Integration	Exploration Science (Orbital Debris, Imagery)	Spacecraft Systems Design & Development	Aircraft Services	Safety & Risk Assessments	Robotics & Automation	Human Health & Performance	Computational Analysis
Commercial Space Markets										
ISS Crew & Cargo Servicing										
Commercial Satellite Launch Services										
Commercial Satellite Manufacturing & Ops										
Space Tourism / Personal Spaceflight										
Applied R&D / ISS Utilization										



# Commercial Space Can Benefit From JSC Expertise



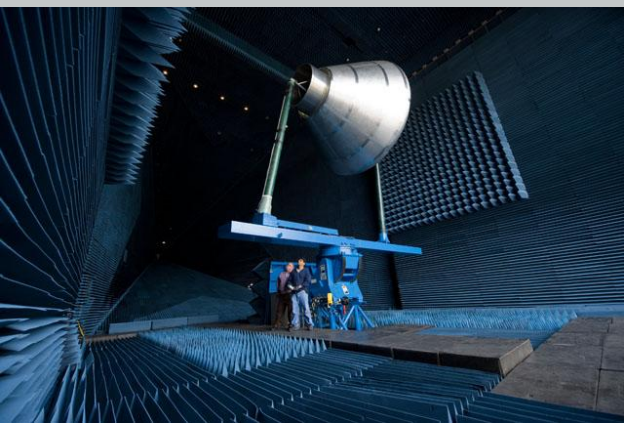
## Examples:

- ✓ Crew safety during ascent and re-entry
- ✓ Testing on in-space propulsion systems
- ✓ Rendezvous & docking operations planning
  - Damage detection / repair resolution for re-entry
  - Radiation shielding and countermeasures
- ✓ Component failure analysis and materials testing
- ✓ Anomaly detection & performance verification
  - Human system interface evaluation
- ✓ Orbital debris risk mitigation
  - Crew health and productivity
- ✓ Avionics reliability and safety
- ✓ Power quality testing
- ✓ Spacecraft / launch vehicle Integration
  - Aerothermal environments

✓ - Work currently  
being provided  
by JSC for  
Commercial Space



# Commercial Space Can Benefit From JSC Facilities



## Examples:

- ✓ **Receiving, Inspection and Test Facility**
- **Antenna Test Facility**
- ✓ **White Sands Test Facility (WSTF)**
  - Propulsion Testing, Hypervelocity Impact Testing, Composite Overwrap Pressure Vessel (COPV) Testing
- **Thermal Vacuum Chambers**
- **Anthropometry and Biomechanics Facility**
- **Structures Test Lab**
- **Systems Engineering Simulator**
- ✓ **Energy Systems Test Area**
- **Spacecraft Vibration Lab**
- **Human-Rated Test Bed**
- ✓ **Radiant Heat Testing Facility**
- **Altitude Test Facilities**
- **Habitability Design Center**
- ✓ **Computational Electromagnetics (CEM) Lab**
- **Spacecraft Acoustic Lab**

✓ - Facilities currently  
being utilized  
at JSC for  
Commercial Space





# End-to-End Lifecycle Support

*As Commercial Space companies progress through each stage of the engineering lifecycle, they can utilize JSC's unique experience and capabilities in those areas*





# Design & Development

## Examples:

- **JSC is working with Ad Astra towards the first in-space demonstration of the Variable Specific Impulse Magnetoplasma Rocket (VASIMR), Ad-Astra's proprietary rocket technology, as a major external payload for the ISS**
  - JSC Rapid Prototyping Lab (RPL) will demonstrate actual operation of VASIMR on the ground, utilizing a model computer to simulate ISS networks and interfaces
- **JSC has an active partnership with Bigelow Aerospace to support the development of expandable space habitat technology**
- **Partnered with Armadillo Aerospace in 2009 to design and test a LOX/CH4 engine**
  - Set the framework for the NASA Morpheus Project, which is open to partnerships with industry and universities to test autonomous landing technologies and develop best practices for lean development



# Testing

## Examples:

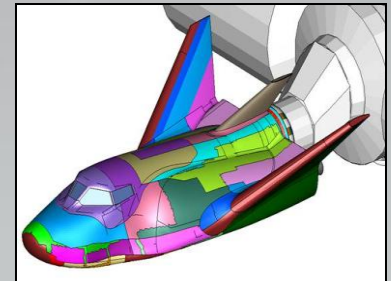
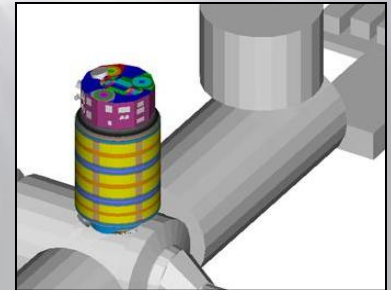
- **Hypervelocity impact tests are being conducted for Commercial Space companies for MMOD protection design considerations**
  - Evaluating alternative shielding materials and mass reduction options
  - Characterizing thermal protection system failure modes
  - Providing data for ballistic limit equations
- **Fastener testing is being performed for the SpaceX Dragon using the JSC Receiving, Inspection, and Test Facility (RITF)**
- **JSC Energy Systems Test Area (ESTA) is being utilized by ULA to provide early developmental, risk reduction tests for pyrovalve cartridges**
- **WSTF is conducting nitrous oxide (N<sub>2</sub>O<sub>2</sub>) compatibility tests on materials and components for Scaled Composites to enable them to make informed decisions to control hazards in N<sub>2</sub>O<sub>2</sub> propulsion systems**



# Analysis

## Examples:

- **MMOD risk assessments are being performed for ISS visiting vehicles such as SpaceX Dragon, Orbital Cygnus, and SNC Dream Chaser**
- **Launch imagery screening and analysis**
  - Planning to support future SpaceX and Orbital launches
- **Providing engineering support to Sierra Nevada for structural loads and capture analysis associated with final approach and docking to the ISS**
- **Performing an analysis of physiological or crew performance data related to the design of the partner's spacecraft, human factors, and human system integration**
- **Providing imagery and lunar surface knowledge support to assess potential visits to historic lunar landing sites by Google X-Prize competitors**





# Operations

## Examples:

- **Providing support to Boeing and Sierra Nevada in the following areas:**
  - Definition of mission operations approaches, including concepts for operations with a joint JSC/Partner team
  - Definition of system requirements in support of operations execution
  - Operations insight for ongoing design of vehicle subsystems, including the spacecraft to Mission Control Center (MCC) interface
- **Recently signed an agreement with ATK to provide information about NASA's mission systems operations, training, planning, and process development**





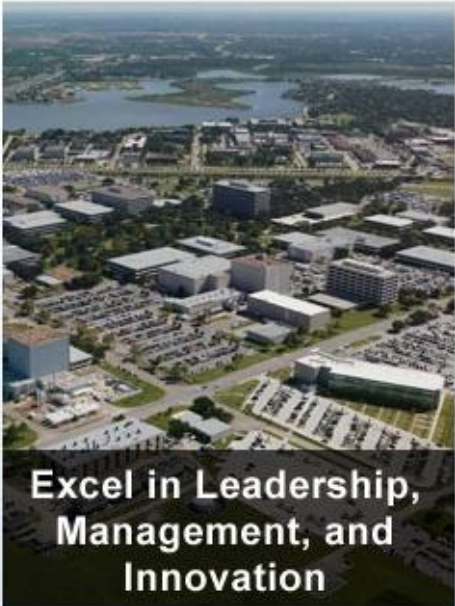
# Overarching Partnership Strategy



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**JSC STRATEGIES SUPPORT EXPLORATION AND COMMERCIALIZATION**

**Success Factors:**

- Aggressively pursue innovative technical and business approaches that drive affordability, sustainability, and accountability
- Develop a customer-focused approach to meet internal/external stakeholder needs
- Develop and implement an investment plan that provides critical capabilities while reducing infrastructure costs and meeting green technology goals

**Strategy 3.1**  
*Lead through innovative  
technical and business  
management practices*

**Strategy 3.2**  
*Lead by Fully engaging the  
human spaceflight team*

**Success Factor:**

- Partner with other NASA centers, gov't, academia, industry, and int'l community to achieve human spaceflight goals





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## JSC STRATEGIES SUPPORT EXPLORATION AND COMMERCIALIZATION

### Success Factors:

- Expand collaborative development with other centers, agencies, industries, international partners, and academia, particularly in the areas of Aerospace, Medicine, Energy, and Transportation
- Maximize technology transfer to, and technology solutions from, commercial applications for economic benefit
- Collaborate with academia and research institutions and utilize open sources for development of multi-use technologies, and promote two-way exchange of knowledge
- Engage intermediaries to enable utilization of facilities and expertise, and foster collaborative development with external entities

### **Strategy 4.1**

***Intertwine JSC in mutually beneficial partnerships to maximize economic and societal impact***

### Strategy 4.2

Inform, educate and engage all generations to advance human space exploration

### Strategy 4.3

Strategically communicate JSC's relevance in terms meaningful to our stakeholders

# JSC's Evolving Culture

- **In 2011, JSC formed the Strategic Opportunities & Partnership Development (SOPD) Office**
  - Serves as the “front door” to the Center for partnership opportunities and agreement formation
  - Continually seeks to improve the business practices of the Center to better meet the needs of commercial partners
- **Paradigm change within the Center**
  - Cultivating relationships with a variety of industries, academia, government, and internationals; seeking to advance technologies and innovation
  - Opening our doors to industry, building the blocks for a future Innovation Center
  - Establishing partnerships through Not for Profit Entities (e.g. BayTech, Houston Technology Center)
  - Creating a more customer focused environment
  - Providing support through non-traditional funding mechanisms (i.e. Funded SAAs vs. Traditional Procurement)
  - Adopting commercial best practices such as rapid prototyping, lean development, etc.



# Examples of Facility Utilization

- **In addition to its standard use for astronaut training, JSC's Neutral Buoyancy Lab (NBL) is currently being utilized by Petrofac Training Services to provide survival and emergency response training for offshore oil workers**
  - As part of the support contractor team, Raytheon Technical Services Company (RTSC) manages and operates the NBL and serves as an intermediary to bring new business into this one of a kind facility
  - Efficiently uses NBL resources while also leveraging a natural public / private partnership to create a center of excellence for training in extreme environments
- **Hot fire testing will take place at WSTF for a Boeing CST-100 thruster to characterize performance and thermal survivability of hardware**







# Closing Thoughts

# Continued Momentum

*Building on past success, JSC is looking to play an even larger role in supporting Commercial Space*

- While ISS crew and cargo servicing will remain the backbone of JSC's support, the Center is making its capabilities available to other Commercial Space markets where JSC's human spaceflight expertise can be applied
- JSC seeks to help develop and incubate new technologies and markets that are important to the success of NASA and the Commercial Space sector
  - Satellite servicing, orbital debris removal, and space traffic management
  - Advanced launch vehicle / operations concepts (e.g. increased flight rate, launch-on-need, rapid turnaround, etc.)
- JSC's vision of the future involves working jointly with Commercial Space companies to develop new exploration capabilities and forge new markets as the nation begins its path of exploration beyond LEO



# Challenges

*JSC is aggressively working through challenges to ensure NASA is appropriately positioned to support Commercial Space*

- **Balancing resources between programmatic work and the increasing demands of JSC's partnership portfolio**
  - Ensuring that the Center delivers on promises to commercial companies while at the same time not overextending its resources to the detriment of future directed / programmatic work
- **Seeking new ways to improve the review and approval process for Space Act Agreements (SAA)**
- **Transforming JSC's business culture to one that's reliable, progressive, innovation-centered and easy to work with**





# Summary

*Commercialization of LEO and partnerships with industry are essential elements of JSC's Strategic Implementation Plan*

*JSC is actively partnering with companies and managing programmatic work related to the Commercial Space sector*

*JSC has an overarching partnership strategy to help advance exploration technologies while maximizing the Center's relevance and benefits to life on Earth*

*With commercial companies as integral members of the team, JSC is continually seeking to increase its involvement in public / private partnerships as a new era of space exploration begins*





Questions?